". . . to conserve to the extent practicable the various species of fish or wildlife and plants facing extinction . . ."

Diversity for the Future: Science and the Challenge of Saving Endangered Species

United States Department of Agriculture • Forest Service

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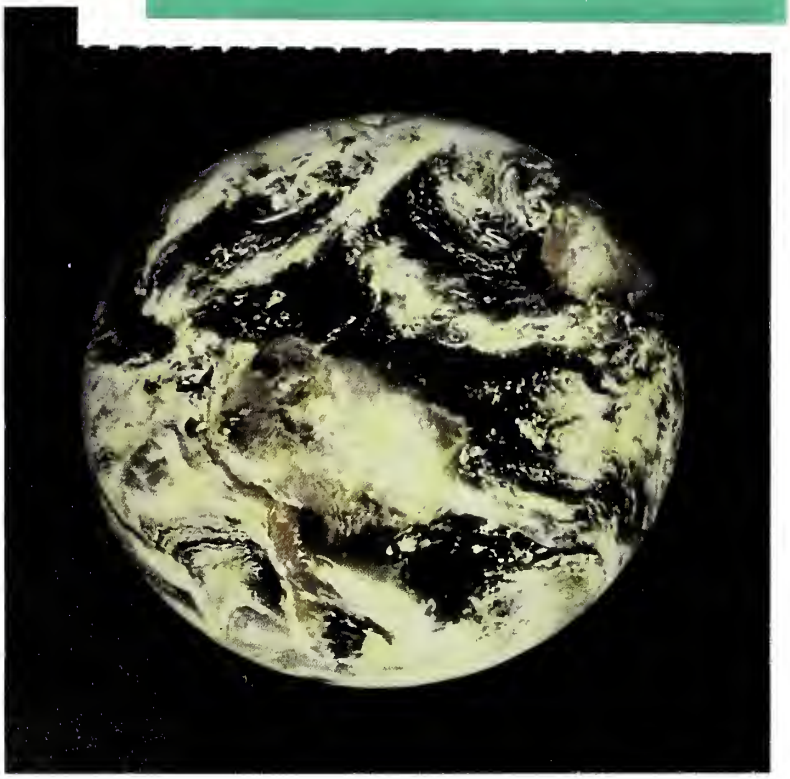


Cover Photo:
Forest Service scientists are studying the life history of the endangered Karner blue butterfly, found in oak-savannah and pine barrens of the central and southern United States.

Science and the Challenge of Saving Endangered Species

Spaceship Earth. When science gave us a platform in space, we saw the planet in its entirety for the first time, in all its splendor—and with all its limitations. Gaining access to space was one of humankind's greatest scientific triumphs.

Saving endangered species on Earth is an equally imposing challenge, requiring both scientific understanding and the development of advanced technologies. Many of these technologies are as experimental as those in space systems, with the added complication that living organisms are more complex than machines. We are just beginning to understand the problem of endangered species, not only as a matter of saving individual species, but also in view of their critical ecological and evolutionary roles.

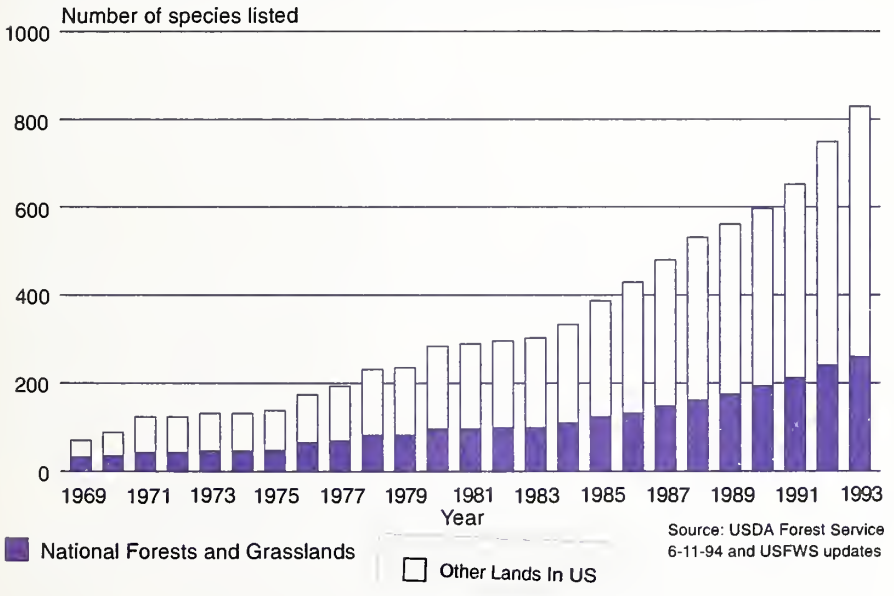
How Big Is the Challenge?

The specter of losing such awe-inspiring wildlife as the whooping crane or the grizzly bear prodded our national conscience and inspired the Endangered Species Act of 1973. The passenger pigeon and Carolina parakeet were already extinct, found only in photos in books and museums. We pledged to reverse the trend.

Delivering on that pledge has proven difficult. Of more than 3,000 species of fish and wildlife and 10,000 species of plants on the National Forests and Grasslands, nearly 250 are federally listed as threatened or endangered. Another 2,250 are designated by the USDA Forest Service as sensitive species whose long-term viability may be at risk.

Although species extinction is a natural process, human activity has greatly accelerated losses. As biologist Daniel Jantzen has said, "It's as though the nations of the world decided to burn their libraries without bothering to see what's in them." The Biodiversity Convention established at the 1992 Rio Conference voiced global concern over the rampant loss of species.

Trends in Threatened and Endangered Listed Species



Biodiversity and Forest Service Stewardship

Biodiversity is inscribed in the very fabric of life. It means preserving natural processes of interaction among species and protecting the complex, constantly changing communities and landscapes that arise from them.

The Endangered Species Act provided the first legal recognition of the importance of biodiversity in proclaiming that "species of fish, wildlife, and plants are of aesthetic, ecological, historical, recreational, and scientific value to the Nation and its people." Accordingly, the Act called upon the Nation "to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved."

Saving the endangered Apache trout requires restoring habitats protected by natural barriers against introduced trout species that would overwhelm it.

The Kirtland's warbler, restricted to a small breeding area in Michigan, depends on fire to maintain conditions suitable for nesting under young jack pines.

Preserving threatened, endangered, and sensitive species is central to the mission of the Forest Service. With more than 191 million acres across 13 ecoregions, the National Forests and Grasslands are home to one-third of all species currently listed under the Endangered Species Act. As other lands are developed, the importance of the National Forests and Grasslands as a refuge for sensitive, threatened, and endangered species is likely to grow.

What Have We Accomplished and What Have We Learned?

The Forest Service is committed to a strong scientific foundation for its Threatened, Endangered, and Sensitive Species Program. Forest Service research focuses on the pro-

cesses and components that make ecosystems work. We are developing scientifically based management techniques to preserve ecological processes and to maintain biologically diverse forests and rangelands with a wide array of values and potential products.

Many research efforts that were initiated to protect endangered species have evolved into broader ecological approaches for restoring and sustaining biological diversity. In particular, programs involving the Puerto Rican parrot, red-cockaded woodpecker, northern goshawk, and northern spotted owl have helped preserve critical ecosystems while teaching us important lessons about ecosystem management and the habitat needs of species.

A captive breeding program developed cooperatively by researchers in the Forest Service and the Fish and Wildlife Service was critical to recovery of the Puerto Rican parrot, especially after the devastation of Hurricane Hugo.

The Puerto Rican Parrot and Tropical Rain Forest

Despite efforts to protect it, the Puerto Rican parrot had all but disappeared from the wild by 1972, reduced to a single population of 14 birds in a remote part of the island. Most of the parrot's old-growth tropical forest habitat had been destroyed by human activity, and reproduction among the remaining few birds was impeded by predation, competition, complex pair formation, small population size, and a lack of suitable nesting sites.

Scientists from the Forest Service and the USDI Fish and Wildlife Service worked together to improve conditions for the Puerto Rican parrot. Natural cavities were modified and artificial structures were designed to provide suitable nesting sites and to reduce predation and competition from the pearly-eyed thrasher. Cavities were closed between June and September to minimize swarming by honeybees. Captive birds were bred to produce young parrots, which were substituted for wild chicks in the nest (cross-fostering) to enhance genetic diversity.

By 1989, the wild parrot colony had grown to about 45 birds. Although nearly half were killed by Hurricane Hugo, joint research and recovery efforts by the Forest Service and Fish and Wildlife Service have already restored the parrot population to prehurricane levels. The next step is to establish new, widely separated parrot colonies to protect the species from disastrous losses in the event of another catastrophe. Young birds will be

moved between flocks to promote genetic diversity.

Lesson Learned: Interagency partnerships synergize research on endangered species.

The Red-Cockaded Woodpecker and Southern Pine Forest

The red-cockaded woodpecker drills its nesting and roosting cavities in several species of southern pine, including longleaf and loblolly pine. It selects trees that are infected with heartrot, generally ones that are 80 years old or more. The bird was once common, but declined to the point of being listed as endangered in 1970. Agriculture, urban development, and forestry practices combined to reduce the mature piney woods that provide the bird's habitat. Old-growth stands were replaced with younger, faster-growing trees, and the natural fire that kept pine stands open and free of hardwoods was eliminated. Remaining red-cockaded woodpecker populations are highly fragmented and isolated. It has been difficult to reverse the bird's decline.

In 1989, when Hurricane Hugo ravaged the Francis Marion National Forest in South Carolina, it devastated the second largest red-cockaded woodpecker population left in the Nation, and the only one known to be growing. In some colonies, winds snapped nearly 90 percent of the trees with active woodpecker cavities. Overall, about 70 percent of the birds disappeared in the hurricane or during the year that followed.

In a crash program designed to save the woodpeckers, technicians created nesting and roosting cavities for the birds using new techniques developed by Forest Service and university researchers. Techniques ranged from drilling start holes and completed cavities (it may take a woodpecker more than 3 years to drill a suitable cavity on its own) to inserting cedar blocks with predrilled cavities into holes cut into trees. By the summer after the hurricane, 45 percent of all red-cockaded

The endangered red-cockaded woodpecker was once found in pine forests throughout the South. Statistical research indicates that hurricanes will continue to be a significant obstacle to the bird's recovery.

Artifical cavities that imitate those made by woodpeckers now contain more than half the red-cockaded woodpecker nests on the hurricane-devastated Francis Marion National Forest.

Restoring endangered species will sometimes require that we carefully restore fire as a process critical to ecosystem management.

woodpecker nests on the Francis Marion National Forest were in artificial cavities, a figure that now exceeds 66 percent. This has helped the population to recover dramatically. The number of adult birds rose by 56 percent between 1990 and 1994.

Artificial cavity technology is now widely used throughout the species' range to help small remnant populations survive. Artificial cavities are a springboard to recovery, but they are not a permanent solution for the bird. Ultimately, the survival of the red-cockaded woodpecker will depend on the Nation's resolve to restore or mimic natural processes and to recover the bird's old-growth habitat.

Lesson Learned: Good science and human intervention may be crucial to the survival of rare or endangered species following a natural catastrophe.

The Northern Goshawk and Ponderosa Pine Forest in the Southwest

A stealthy hunter, the northern goshawk moves silently through the lower forest canopy, searching for prey in the open spaces on or near the forest floor. An interdisciplinary team of ecologists, ornithologists, and land managers found that goshawk habitat is disappearing in Arizona's ponderosa pine

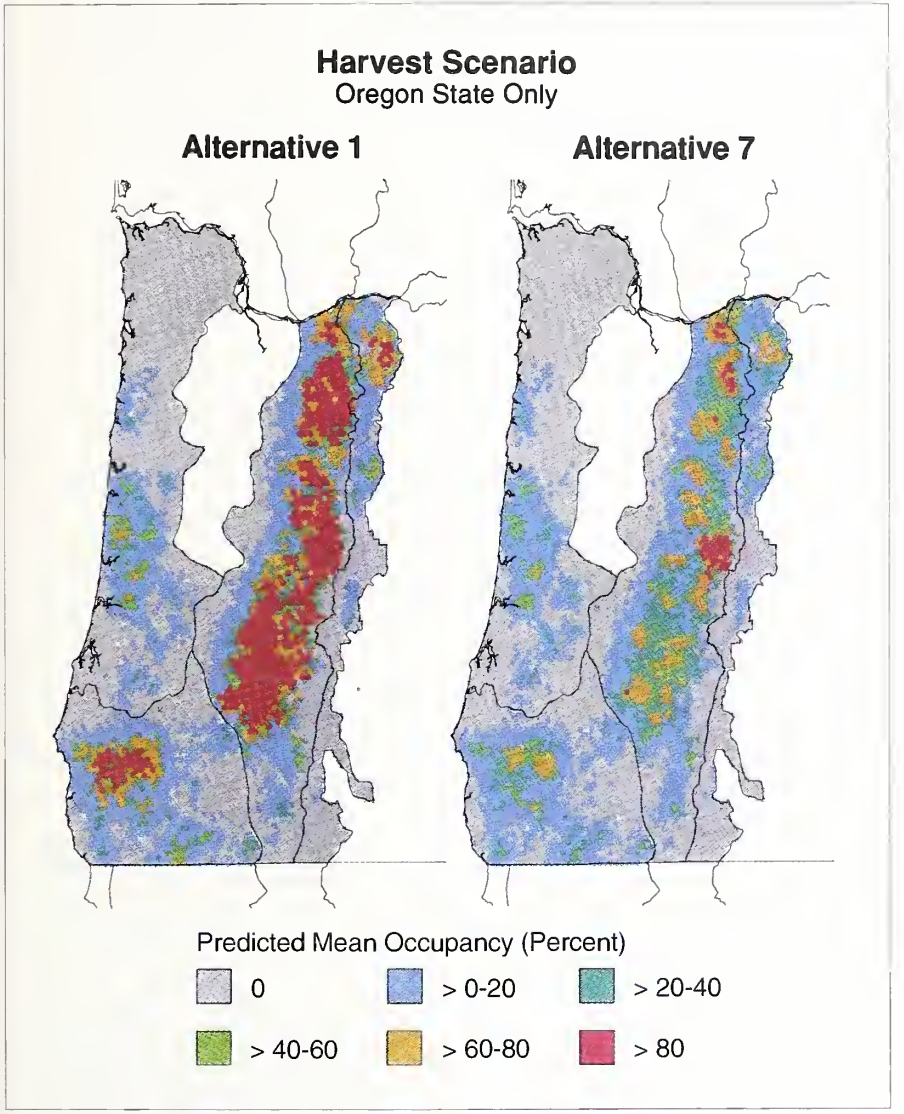
forests. Today's dense stands bear little semblance to the open, parklike forests described by early settlers in the Southwest. Big trees have been harvested, and aggressive fire control has allowed dog-hair thickets to form, choking out the plant species required by goshawk prey and interfering with the goshawk's ability to swoop down through the trees. Moreover, the goshawk has lost much of its prime nesting habitat in the dense upper forest canopy provided by mature ponderosa pines.

The interdisciplinary team found that forests containing trees of various ages provide the best habitat not only for the goshawk, but also for a broad array of prey species. Large old trees and snags contain nesting cavities for squirrels, chipmunks, and many birds. Younger trees and patches of open ground provide forage for grouse and rabbits. Mushrooms sprouting from decaying logs feed rodents, which in turn spread fungi spores throughout the forest in a dynamic process of natural recycling.

Can we maintain such recycling processes in a managed forest? We know enough to get started. Dense thickets should be thinned to reduce the danger of catastrophic wildfire; then low-intensity prescribed fires can be used to mimic the processes that formed the ponderosa pine ecosystem. Stands of mature trees with dense canopies should be retained around known goshawk nesting sites. Some trees can be harvested in zones beyond nesting areas, where young goshawks can develop their hunting skills. But in general, a mosaic of small forest openings and stands of varying ages should be cultivated so that harvested stands or trees lost to catastrophe or to natural processes will always be replaced by other parts of the forest that have just reached maturity.

A northern goshawk waits quietly for prey to move in the subcanopy below.

Lesson Learned: Interdisciplinary efforts to understand the ecology of individual species are the building blocks of comprehensive, landscape-level strategies.



Models of habitat and populations were used to generate geographic information system (GIS) maps predicting occupancy by pairs of northern spotted owl under different management scenarios over the next 100 years.

The Northern Spotted Owl and Ancient Forest in the Pacific Northwest

For more than 20 years, scientists have indicated that the northern spotted owl depends for its survival on a habitat peculiar to the old-growth forests of the Pacific Northwest. Throughout much of its range, the northern spotted owl preys on small mammals that feed on lichens sprouting on the upper branches of ancient conifers. Research has shown that spotted owl populations are declining with the disappearance of ancient forests. Moreover, as many as 1,000 other plant and animal species could be adversely affected by the loss of old growth. As marbled murrelets and anadromous (sea-running) fish species in the Pacific Northwest began to decline as well, researchers came to realize that it was not only individual species that were at risk, but entire communities of fish, plants, and wildlife. Research on spotted owl habitat broadened to include all the processes that sustain old-growth forests in the Pacific Northwest. What role, for example, do fallen logs play in sustaining the fungi that feed the rodents that owls and weasels prey on? And what happens when there are no longer as many fallen logs because ancient trees are harvested?

Such ecosystem-oriented questions influenced the Forest Ecosystem Management Assessment Team (FEMAT) report commissioned by President Clinton in April 1993. The report calls for (1) protecting against loss of

Lichens draped from this spotted owl's perch are a staple in the diet of flying squirrels, a favorite owl prey.

biodiversity and ecological processes, (2) speeding development of late-successional stages in regenerating forest, and (3) mimicking the effects of natural processes such as storms, wildfires, and insect and disease outbreaks in mosaic patterns across forest landscapes. But because it took a century and a half to produce the ecological crisis in the Northwest, there will be no quick fix.

Lesson Learned: Maintaining ecosystems is more complicated than we had anticipated. Research must be an ongoing, integral part of forest management if we are to maintain healthy ecosystems and their native diversity.

Ecosystem Management: The Evolution of Endangered Species Research

These stories illustrate the progression in Forest Service research from a focus on individual species to the study of habitats, communities, processes, and ecosystems. Forest managers at all levels now recognize the need for an interdisciplinary approach to forest planning and decisionmaking on the basis of sound scientific research. This approach, known as ***adaptive management***, requires us to (1) gather the best scientific information available, (2) apply it in making decisions about resource management, (3) monitor the results of management activities, (4) analyze findings to determine whether objectives are being met, and (5) modify activities accordingly.

Adaptive management—now the point of departure for Forest Service research on threatened, endangered, and sensitive species—is thus an ongoing experiment in ecosystem management. Its scientific basis requires close collaboration between managers and scientists, lending ecological credibility to decision making about resources.

To gather the best scientific information available, the Forest Service prepares ***Habitat Conservation Assessments*** summarizing what we know about the biology and ecology of at-risk species over large geo-

graphical areas. Then we analyze the implications for management and make recommendations for further research. These assessments provide a basis for planning in accordance with the principles of adaptive management. But their ultimate purpose is to help forest managers anticipate problems and develop strategies to protect species before they are seriously threatened.

Pacific Anadromous Fish

The most significant Habitat Conservation Assessment to date relates to Pacific anadromous fish species—salmon, steelhead, and sea-run cutthroat trout that originate in West Coast watersheds, migrate to the sea, and return to reproduce in their natal streams. Over 400 stocks of these salmonids have been identified; a quarter are now extinct, and another half are considered at risk.

Which is critical salmon habitat? The rushing torrent is pretty, but a small pond upstream provides essential nutrients and shelter for newly hatched coho salmon until they are ready to migrate to sea.

Sport, commercial, and subsistence harvest, the development and operation of hydroelectric dams, and the deleterious effects of fish hatcheries (including disease generation and genetic weakening) have all contributed to the decline of Pacific salmonids. But the most serious threat to remaining stocks comes from degradation of habitat due to human activity.

The Forest Service has joined with the Bureau of Land Management to develop a common strategy for managing watersheds critical to Pacific salmonids. Known as PACFISH, the effort integrates the skills of land managers and technical specialists with the scientific expertise of Forest Service researchers. Based on sound science, PACFISH takes a proactive ecosystems approach to managing anadromous fish habitats in California, Idaho, Oregon, and Washington. Riparian corridors along sensitive streams are managed under conservative interim guidelines while scientists develop ways to restore and sustain the ecological processes that gave rise to once-thriving salmonid populations.

Other Habitat Conservation Assessments provide a scientific basis for restoring and sustaining a variety of rare and endangered species, including the bull trout, marbled murrelet, California spotted owl, great gray owl, flamulated owl, boreal owl, and small carnivorous mammals (lynx, fisher, pine marten, and wolverine). In the process, we are helping to preserve a vast array of other species that are linked to at-risk species through ecological interdependency.

Stewards of the Future

The conservation of species is central to sustainable ecosystem management. The Forest Service is working hard to build programs with strong scientific foundations that help us understand the impact of human activities on other species so we can create the technologies needed to restore and sustain healthy, diverse ecosystems on the National Forests and Grasslands. We work closely with universities, nongovernmental organizations, and local, State, and Federal agencies in a network of partnerships across the United States and in other countries. Together we are exploring still-unknown aspects of species, habitats, and ecological relationships and discovering new ways to sustain healthy air, lands, and waters and their unique expressions of biodiversity.

Why worry about the loss of species? Beyond what the law requires of us, we have an ethical responsibility as wise stewards of the land to sustain the ecological processes that have shaped the Nation's forests and rangelands. But the challenge we face goes beyond our Nation's borders, affecting people around the world. Food, medicines, and other products have their origins in wild stocks, the biological wealth of nations. Learning to sustain nature's resources on a global scale—to save not only the whooping crane and the grizzly bear, but also the panda bear and the mountain gorilla—is one of the most critical challenges facing this and future generations. Sound scientific research on species and the ecosystems on which they depend will help us meet the challenge of preserving diversity for the future.

A Habitat Conservation Assessment will help us determine the status and needs of several small carnivore species, such as this pine marten.

Managers and scientists working together to understand the natural history and needs of such rare species as the boreal owl (shown here as a chick) help to ensure their survival.

Sound scientific research on species and the ecosystems upon which they depend is critical to the conservation of biodiversity nationally as well as globally.

Research shows that fall burning of midgrass prairie benefits reproduction of the snow-white prairie fringed orchid, an endangered plant species of the northern Great Plains.

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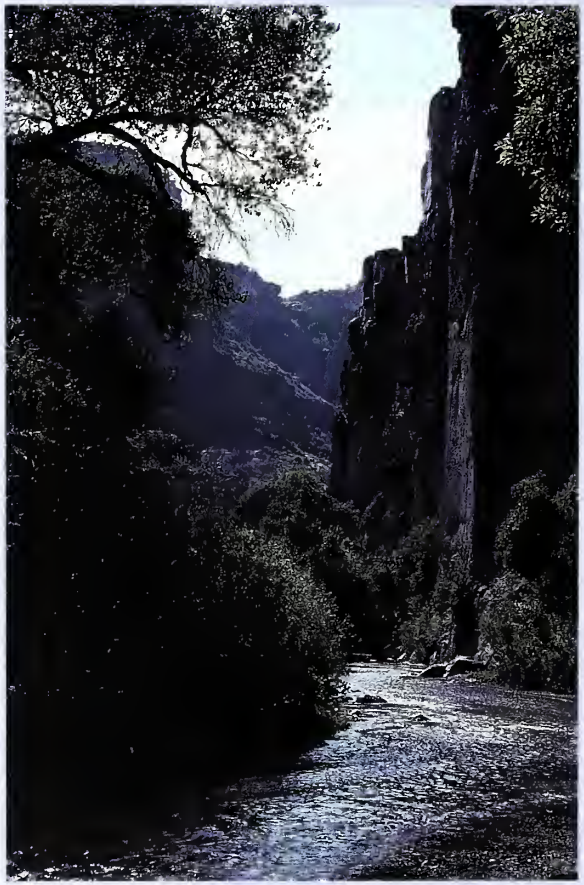
"Eventually, all things merge into one.
And a river runs through it."
(Norman Maclean)



Aravaipa Creek, one of the best areas of native fish habitat remaining in Arizona, is an expression of the watershed it drains.